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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/730,941	12/10/2003	Jae Suk Lee	021906-0306952	6290
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PILLSBURY WINTHROP SHAW PITTMAN, LLP			EXAMINER	
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MCLEAN, VA 22102				
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 10/730,941	Applicant(s) LEE, JAE SUK	
	Examiner EUGENE LEE	Art Unit 2815	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 8/20/08.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-3,5,6,13 and 15-17 is/are pending in the application.
 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-3,5,6,13 and 15-17 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
 Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
 Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
 a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date: _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date: _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 1-3, 5, 6, 13, and 15 thru 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Omstead (US Pat. 6,713,373) in view of Chyan et al. (US PGPub 2004/0051117, hereinafter Chyan).

Regarding claims 1, 15 and 17, Omstead discloses (see, for example, FIG. 8) a barrier structure for copper metallization, comprising: a dielectric pattern 304 disposed directly on an upper surface of a substrate (not shown) (col. 3, lines 60-63); a first barrier layer (TaN) (not shown) (col. 6, lines 11-15) disposed directly on an upper surface of the dielectric pattern; an RuO₂ film 404 (col. 3, line 54) disposed directly on an upper surface of the oxide film; a second barrier (Ru) layer 504 disposed directly on an upper surface of the oxide film; and a Cu layer 604/704 disposed directly on an upper surface of the second barrier (Ru) layer. Omstead does not specifically disclose the first barrier layer is a Ru layer. However, it is very well known in the art to use Ru as a copper diffusion barrier layer. For instance, Chyan discloses (see, for example, (paragraph [0023]) using Ru as a diffusion barrier layer between a copper interconnect and a dielectric layer. Chyan further discloses in the same paragraph that TaN may be replaced by more conductive barrier materials such as Ru. In view of such teaching, it would have been obvious to the ordinary artisan at the time the invention was made to modify the invention of Omstead by using Ru as the lower barrier layer instead of TaN for the purpose of selecting a material

Art Unit: 2815

with greater conductivity, and ridding the copper seed step. Furthermore, it would have been obvious to one of ordinary skill in the art to try a Ru barrier layer as taught by Chyan with the barrier structure taught by Omstead to achieve the predictable result of improved barrier properties with improved conductivity. *KSR International Co. v. Teleflex Inc.*, 82 USPQ2d 1385 (2007).

Regarding the limitation "formed by a plasma treatment using N₂O or O₂" is merely a product-by-process limitation that does not structurally distinguish the claimed invention over the prior art. The patentability of a product does not depend on its method of production. If the product in the product-by-process claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process. *In re Thorpe*, 227 USPQ 964, 966.

Regarding claim 2, Omstead does not specifically disclose the substrate is a silicon substrate. However, the Examiner takes Official Notice that it is very well known to use silicon substrates for the purpose of selecting an inexpensive semiconductor material (among other reasons).

Regarding claim 3, the limitation "the first Ru layer and the second Ru layer are formed by using a sputtering or CVD (chemical vapor deposition)" is merely a product-by-process limitation that does not structurally distinguish the claimed invention over the prior art. A further difference between Omstead and the claimed invention is the first and second layers have a thickness in a range from about 80 angstroms to about 120 angstroms. However, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the invention of Omstead by using the claimed range, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

Regarding claim 5, the product-by-process limitation "obtained by oxidizing an upper part of the first Ru layer" does not structurally/patentably distinguish the claimed invention over the prior art. A

Art Unit: 2815

further difference between Omstead and the claimed invention is the thickness of the oxide film is about 250 angstroms. However, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the invention of Omstead by using the claimed range, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

Regarding claims 6 and 16, a further difference between Omstead and the claimed invention is the ratio of $x:y = 1:2$ (Ru_xO_y). Chyan discloses a conductive barrier layer formed of RuO_2 (paragraph [0023]). In view of such teaching, it would have been obvious to the ordinary artisan at the time the invention was made to modify the invention of Omstead by using the stoichiometry of RuO_2 (wherein $x:y = 1:2$) as taught by Chyan, since RuO_2 is the most readily formed and stable stoichiometry for ruthenium oxide.

Regarding claim 13, after the above combination, the first Ru layer, the oxide film, and the second Ru layer collectively form a conductive barrier structure for the Cu layer.

Response to Arguments

3. Applicant's arguments filed 8/20/08 have been fully considered but they are not persuasive.

Regarding the applicant's argument on page 6 of the amendment filed 8/20/08 that Applicant has determined that the use of a $Ru/Ru_xO_y/Ru$ multilayer structure provides unexpected results in terms of electric conductivity and copper diffusion barrier, as opposed to a TaN structure, this argument is not persuasive. The Examiner recognizes that references can not be arbitrarily combined and that there must be some reason why one skilled in the art would be motivated to make the proposed combination of primary and secondary references. In re Nomiya, 184 USPQ 607 (CCPA 1975). However, there is no

Art Unit: 2815

requirement that a motivation to make the modification be expressly articulated. The test for combining references is what the combination of disclosures taken as a whole would suggest to one of ordinary skill in the art. In re McLaughlin, 170 USPQ 209 (CCPA 1971). References are evaluated by what they suggest to one versed in the art, rather than by their specific disclosures. In re Bozek, 163 USPQ 545 (CCPA 1969). In this case, Chyan clearly discloses (see, for example, paragraph [0023]) replacing a barrier material TaN, which is also disclosed in Omstead as a barrier material, with Ru because of a greater conductivity. Further, Chyan states that using Ru and similar materials may eliminate the need of an additional Cu seed layer. Such a Cu seed layer is present in main reference Omstead (see element 804 of FIG. 8) which overlies Cu fill 704. Clearly replacing the barrier material TaN of Omstead with Ru of Chyan would be obvious to one of ordinary skill in the art because it provides greater conductivity and rids the step of adding a Cu seed layer, which the main reference Omstead discloses.

Regarding the applicant's argument on page 6, first paragraph that the configuration is less desirable in view of Omstead's own teaching because it would reduce the adhesion between the copper layer and the dielectric layer, this argument is not persuasive. Omstead is silent to whether this configuration is less desirable and only states that it is an alternative embodiment to a bilayer. In column 6, lines 11-19, Omstead clearly states a barrier layer may be included with the bilayer.

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing

Art Unit: 2815

date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

INFORMATION ON HOW TO CONTACT THE USPTO

Any inquiry concerning this communication or earlier communications from the examiner should be directed to EUGENE LEE whose telephone number is (571)272-1733. The examiner can normally be reached on M-F 8-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kenneth Parker can be reached on 571-272-2298. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Application/Control Number: 10/730,941

Page 7

Art Unit: 2815

Eugene Lee

November 20, 2008

/Eugene Lee/

Primary Examiner, Art Unit 2815